Efforts of Electric Power Companies and Opinions regarding Best Mix of Energy Sources

February 14, 2012

The Federation of Electric Power Companies

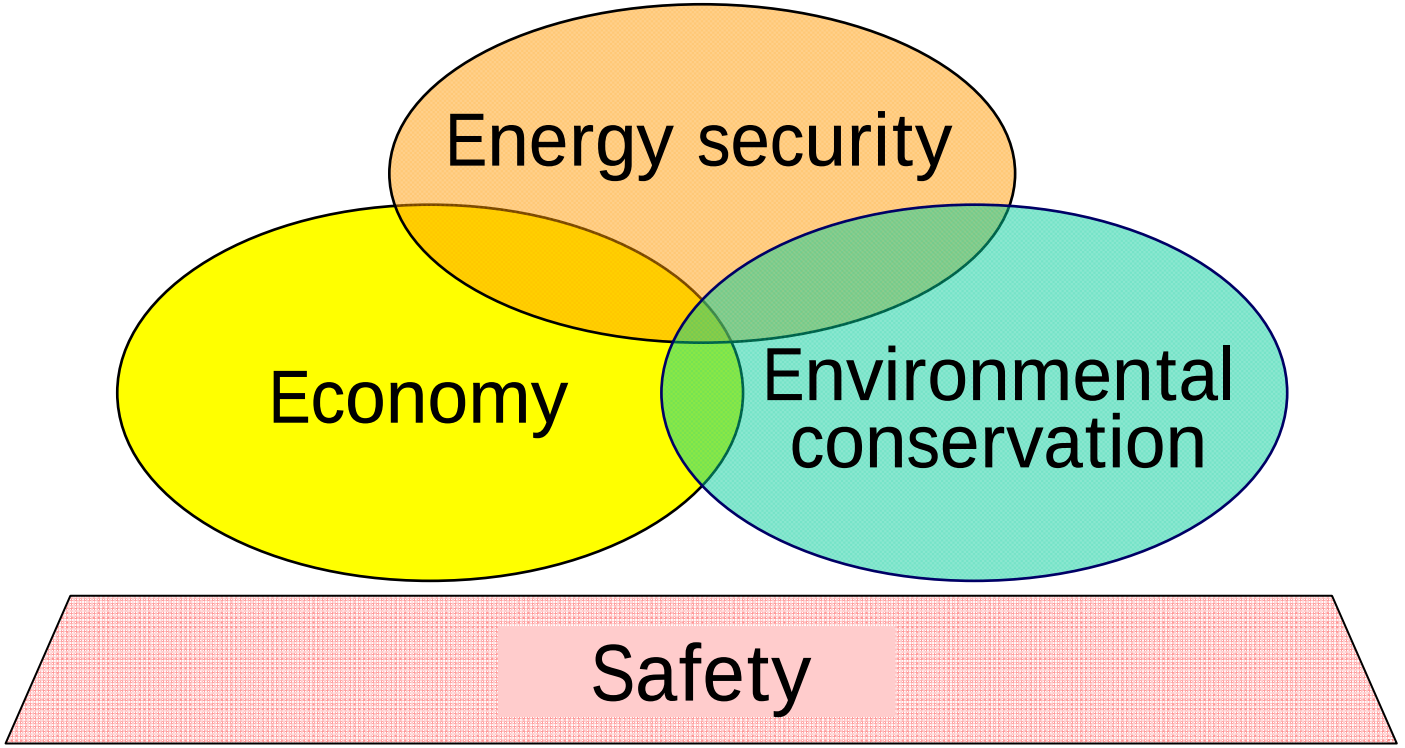
I. Efforts made so far to Achieve the Best Mix of Energy Sources and the Situation after the Great Earthquake

II. New Efforts for Achieving the Revised Best Mix of Energy Sources

III. Conclusion

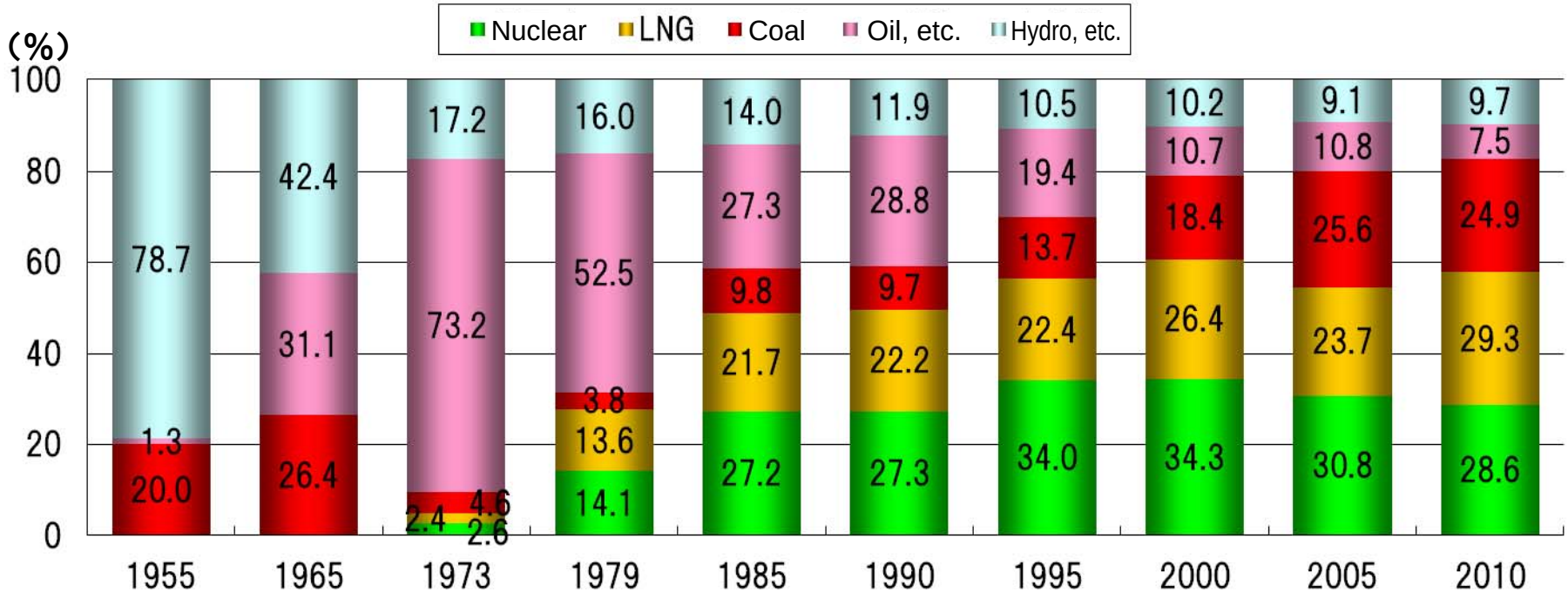
I. Basic Viewpoints to Consider the Best Energy Mix (3Es)

Stable supply of high-quality and inexpensive electricity to our customers



I. Changes in Energy Policy and Diversification of Power Sources in Japan

- We have structured an optimum combination of power sources with a variety of options based on the changes in social conditions and energy policy in Japan.
- We have succeeded in achieving the well-balanced combination of power sources spending approximately 40 years since the oil crisis. Therefore, we propose to examine the best mix of energy sources also taking into consideration an extensive time axis.
- Heavily relying on imported energy resources, Japan must pursue a well-balanced combination of power sources without depending on the specific energy source.

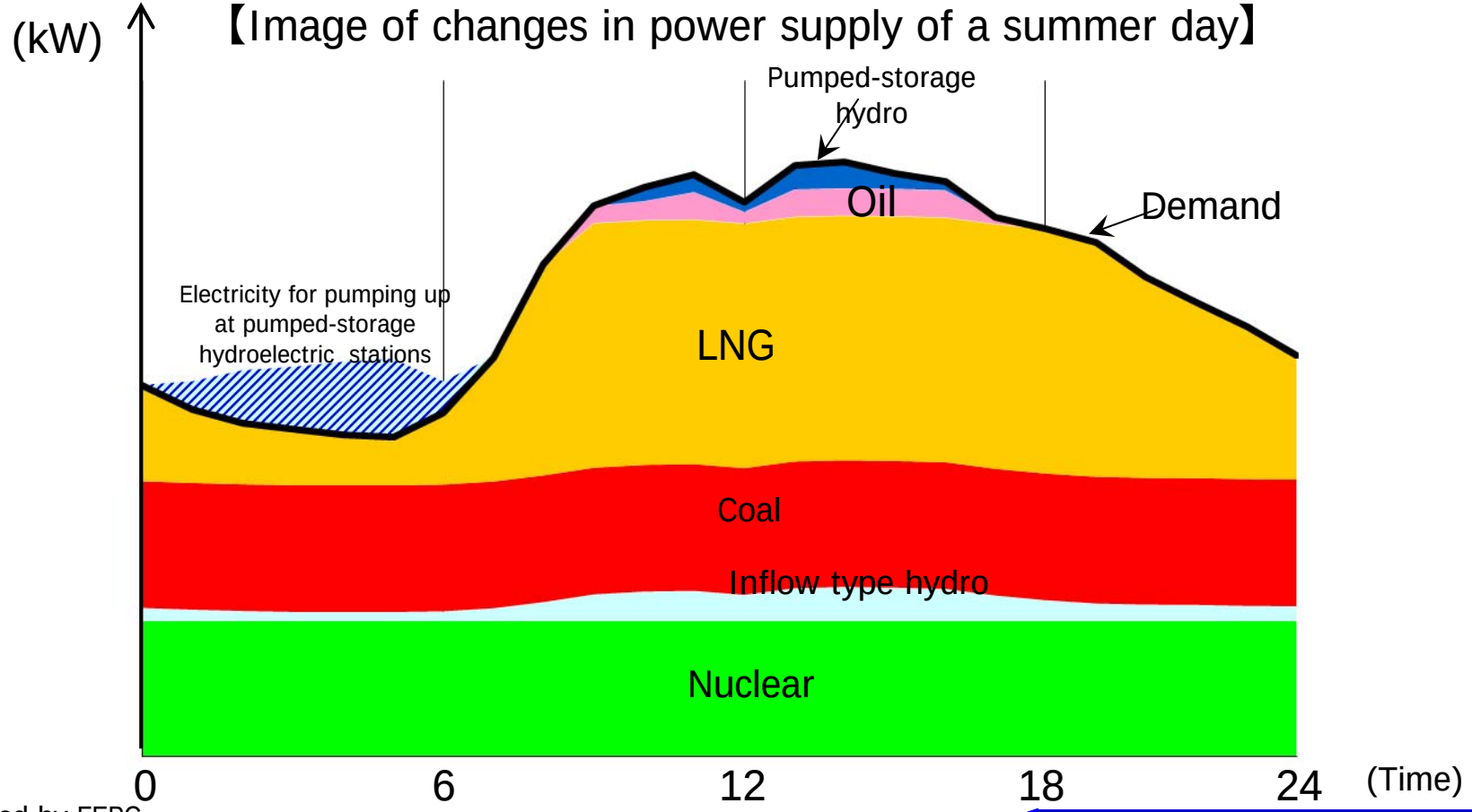


Source: Outline of Power Source Development, etc.

I. Combination of Power Sources in Response to Changes in Demand

- In recent years, nuclear power generation superior in terms of fuel supply and price stability bears to support the basis of the power source combination, while thermal and hydro power including pumped-storage hydro are used to respond to the demand changes.
- Each power source has both merits and demerits. It is important to use the power source taking advantage of its merits.

【Image of changes in power supply of a summer day】

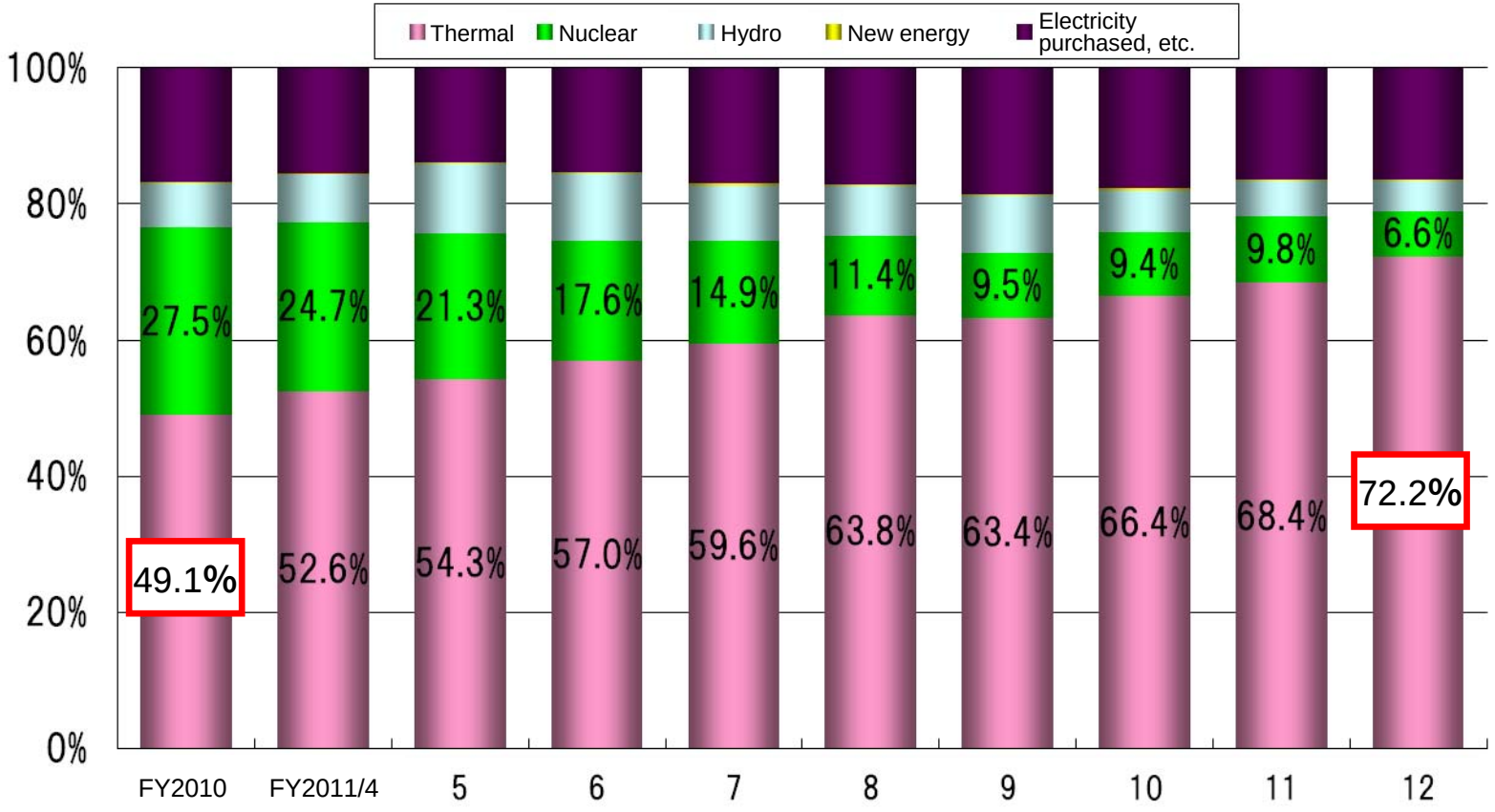


Prepared by FEPC

I. Supply-Demand Situation after the Great Earthquake

- Decrease in the amount of nuclear power generation has been substituted by thermal power generation. Thus, the rate of thermal power generation in the gross generation reached as high as approximately 72% in December 2011, in comparison to approximately 49% in FY2010.
- Japan has been facing extremely tight supply-demand balance due to shutdown of most of its nuclear power plants.

【Rate of nuclear/thermal power accounting for the gross generation】

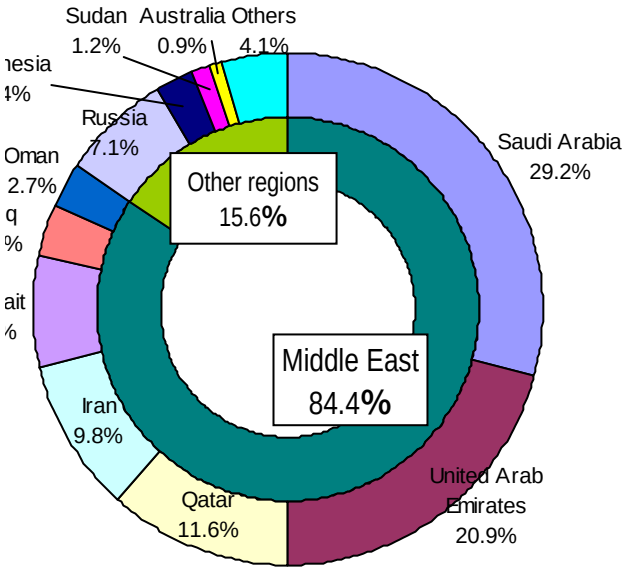


Source: Electricity Generated and Purchased (Bulletin)

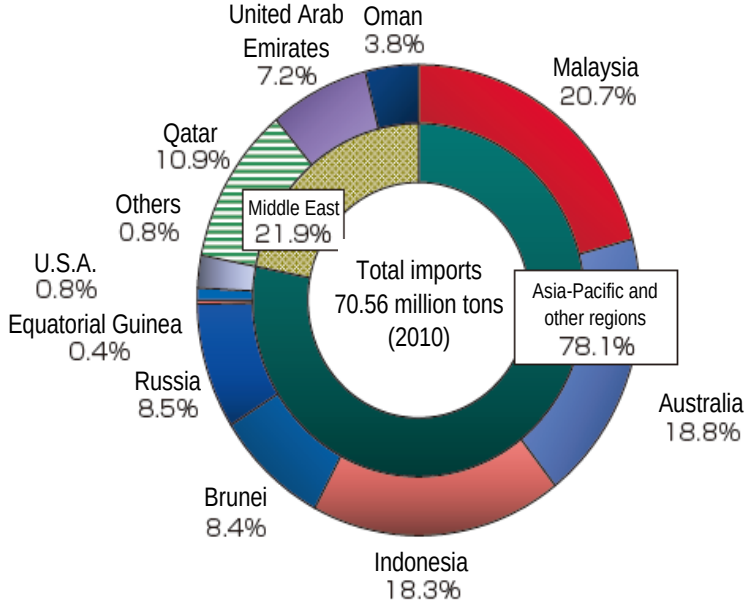
I. Fossil Fuel Exporters to Japan

- Japan relies on more than 80% of crude oil and approximately 20% of LNG imports from the Middle East countries although coal producers are distributed to relatively politically stable regions.
- Japan needs to avoid excessive dependence on LNG and oil for energy security and for continuing to have international bargaining power.

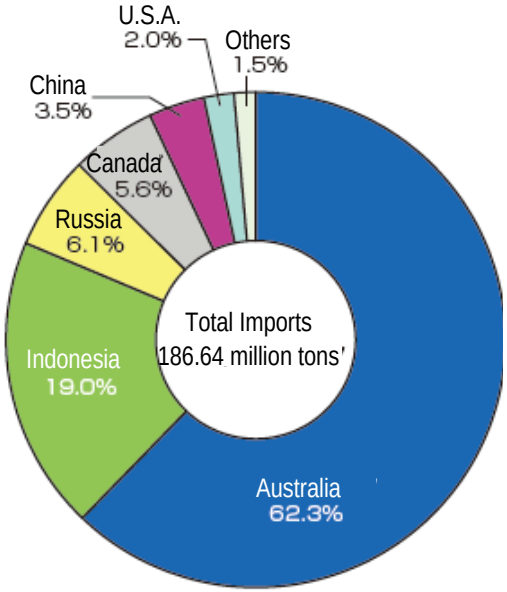
【Crude oil】



【LNG】



【Coal】



Source: Energy White Paper 2011

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II. Emerging Challenges after the Great Earthquake

◆ The following challenges on Japan's energy mix have been raised since the Great Earthquake.

Demand side	Supply side
✓Drastically reinforce energy conservation and electricity saving measures, taking into account changes in behavior of customers and social infrastructure.	✓Accelerate development/utilization of **renewable energy** to the maximum degree. ✓**Effectively utilize fossil fuels** including shifting to natural gas, paying utmost attention to environmental burden (clean use of fossil fuels). ✓Reduce dependence on **nuclear power generation** as few as possible.

Source: Advisory Committee on Energy and Natural Resources, Committee on Basic Issues
'Examination of Issues for Developing the New "Basic Energy Plan'" (December 20, 2011)

II-1. Demand Side Efforts: Basic Principles

◆ The importance of demand side efforts, including peak shifting, was recognized again due to supply constraints on an unprecedented scale after the earthquake.

⇒ Reinforcement of smart meters, planning of an incentive rate program to encourage peak shifting

Efforts last summer & this winter

○ Offering our customers more extensive supply/demand adjustment options according to the supply/demand situation

Examples of options offered by KEPCO:

- Incentive rate options to encourage establishment of new holidays, adjustment of operation system, and peak shift
- Incentive rate options to encourage load reduction at our request when the supply/demand balance becomes tight

Future efforts

○ Installing smart meters

KEPCO's plan for installing smart meters:

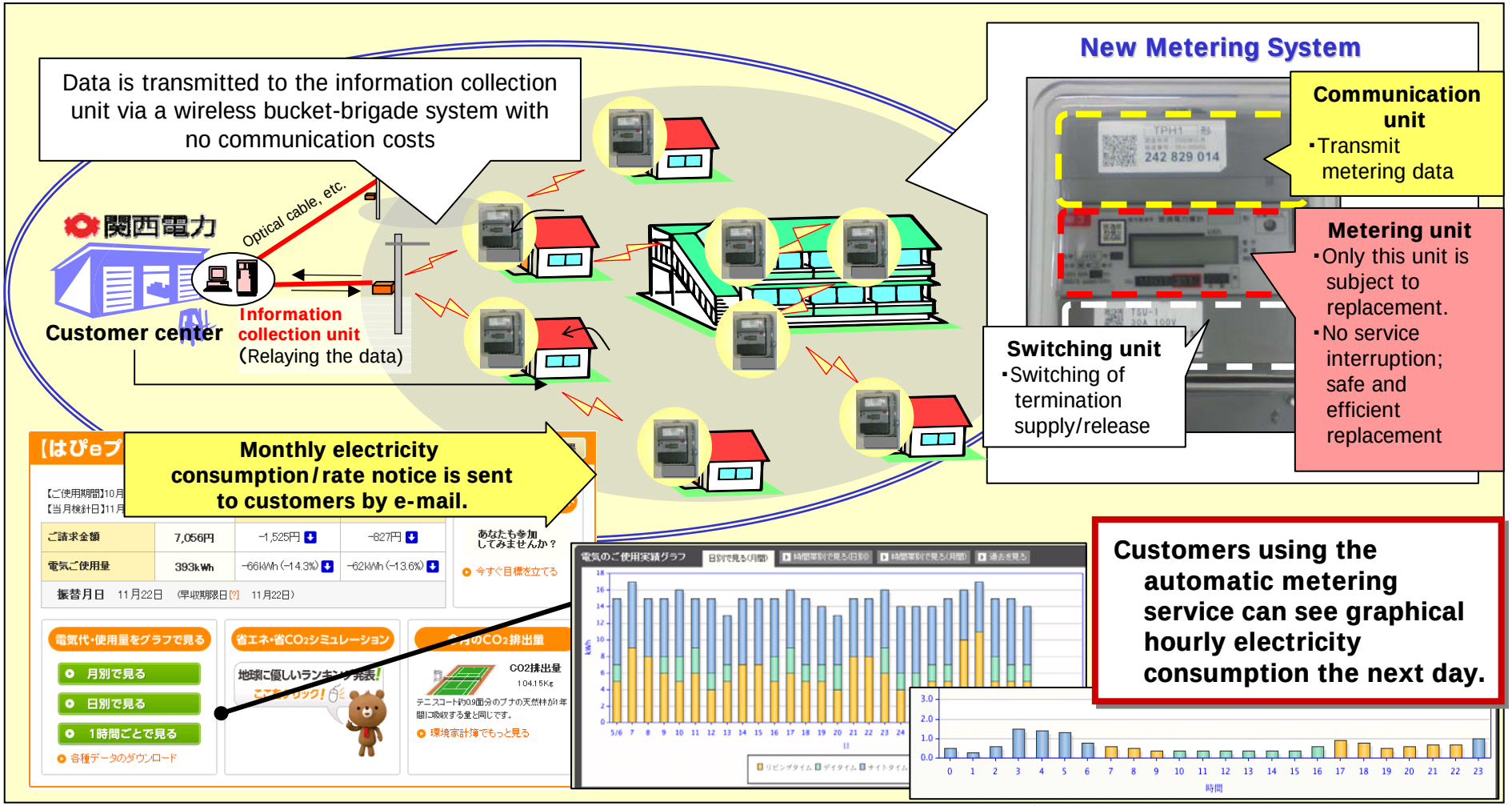
- KEPCO plans to complete the introduction of smart meters to approximately 80% of customers within 5 years.
  All high-voltage demand customers will be covered by smart meter services within 5 years.
  50% of low-voltage demand customers will be covered by smart meter services within 5 years, and the remaining customers within approximately 10 years.

○ Further development of incentive rates and services in response to the supply/demand situation

II-1. Demand Side Efforts: Introduction of Smart Meters

- Electric power companies are committed to actively introducing smart meters to achieve the target set by the Energy and Environment Council.

KEPCO's efforts: Outline of New Metering System



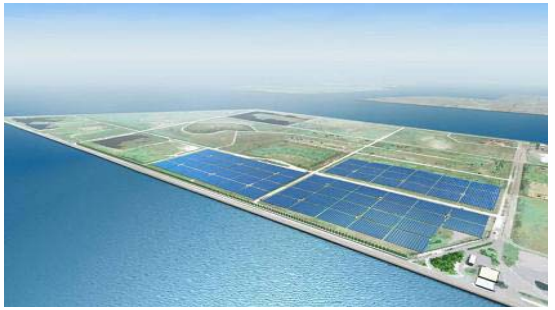
II-2. Demand Side Efforts: Introduction of Renewable Energy (2/2)

- In view of energy self-sufficiency and reduction of CO_2 emissions, the ten power companies are committed to aggressively utilize renewable energy resources.
- The ten power companies plan to develop approx. 30 Mega Solar Plants with capacity of approx. 140 MW in total by FY2020.

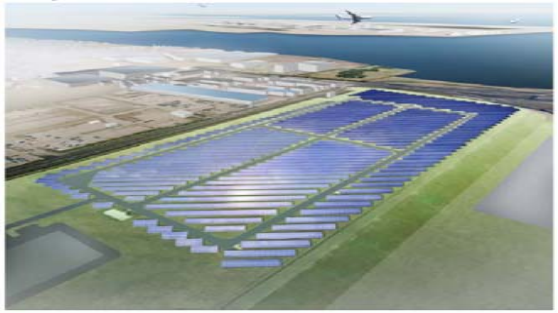
Mega Solar Power Stations in Operation

EPCO	Capacity (MW)	COD	Mega Solar Power Station
Hokkaido	1	2011.6	Date Solar Power Plant
Tohoku	1.5	2011.12	Hachinohe Solar Power Station
Tokyo	7	2011.8	Ukishima Solar Power Plant
	13	2011.12	Ohgishima Solar Power Plant
	10	2012.1	Mt. Komekura Solar Power Plant
Chubu	7.5	2011.10	Mega Solar Taketoyo
	1	2011.1	Mega Solar Iida
Hokuriku	1	2011.3	Shika Photovoltaic Power Station
	1	2011.4	Toyama Photovoltaic Power Station
Kansai	10	2011.9	Sakai Solar Power Station
Chugoku	3	2011.12	Fukuyama Solar Power Plant
Shikoku	2	2010.12	Matsuyama Solar Power Station
Kyushu	3	2010.11	Omuta Photovoltaic Power Station
Okinawa	4	2010.10	Demonstration Research Facility in Miyako Island.
Total	65		

Sakai Solar Power Station of KEPCO
Full scale COD: Sept. 2011



Ukishima Solar Power Plant of TEPCO
COD: Aug. 2011

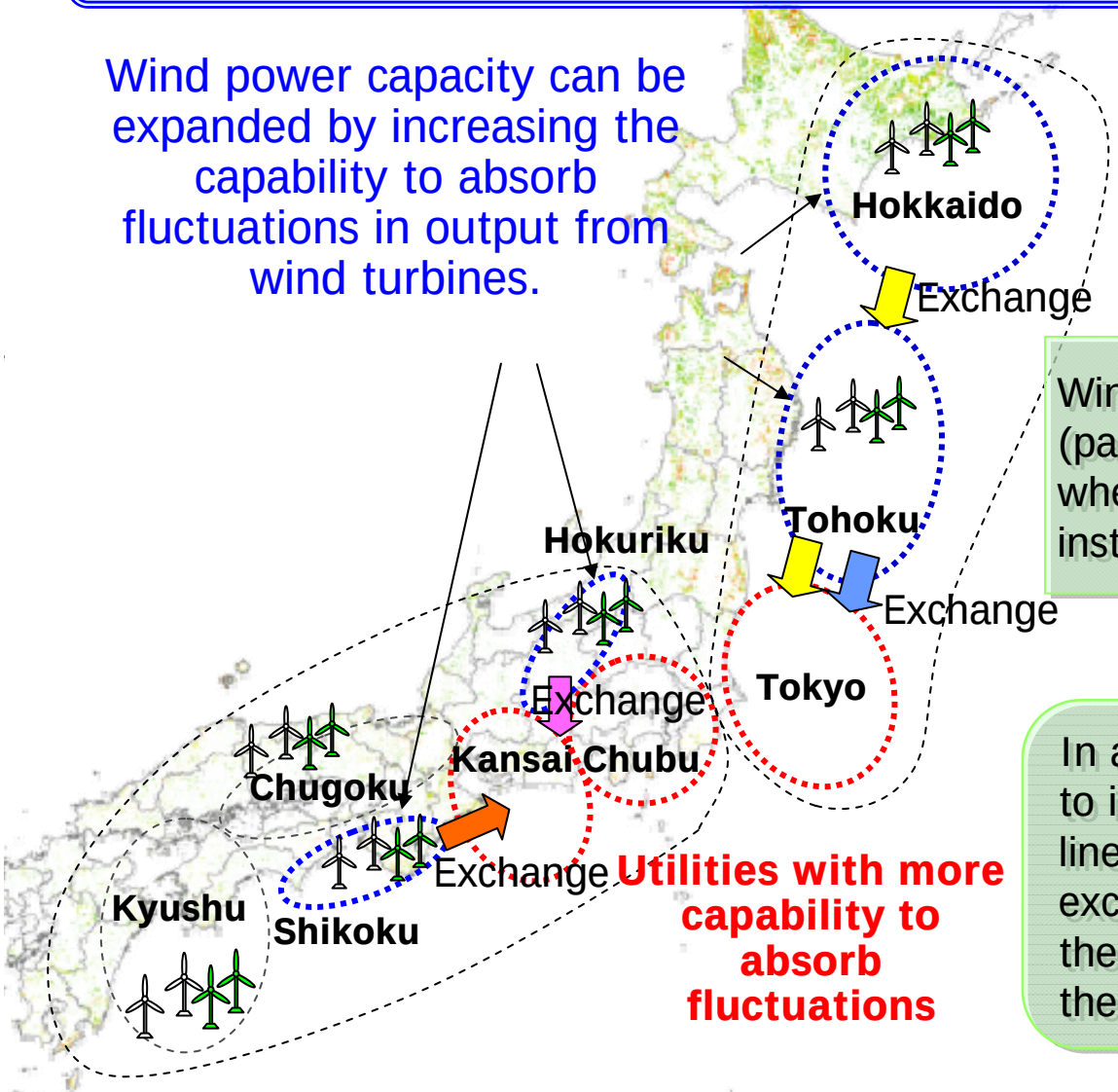


As of Jan. 2012. Projects smaller than 0.5MW capacity are excluded.

II-2. Demand Side Efforts: Introduction of Renewable Energy (2/2)

◆ Utilities are collaborating to expand the use of wind power.

Wind power capacity can be expanded by increasing the capability to absorb fluctuations in output from wind turbines.



Utilities with more capability to absorb fluctuations

Wind power is expected to increase (particularly in Hokkaido and Tohoku where there is larger potential for installing wind turbines).

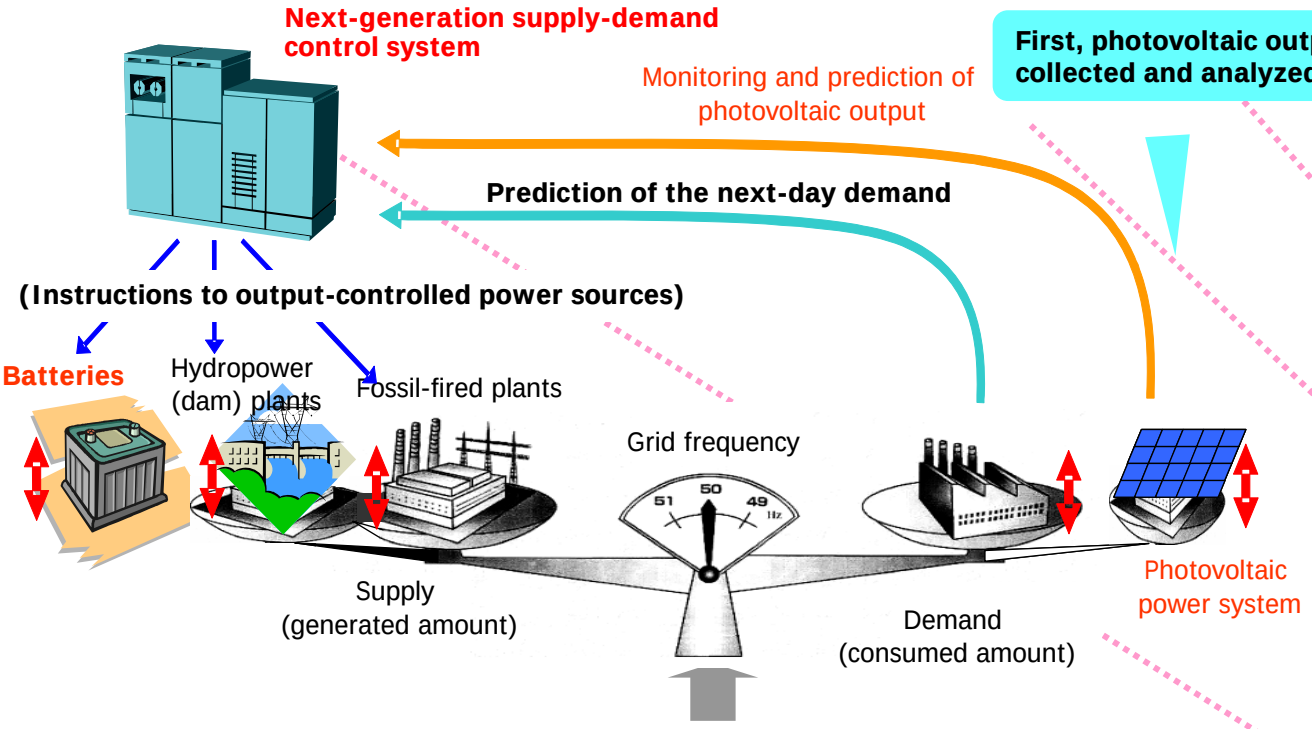
In areas where wind power is expected to increase significantly, interconnection lines are used to enable power to be exchanged among utilities, increasing the capacity to absorb fluctuations in the outputs from wind turbines.

Source: compiled from “Report on Survey Concerning the Deployable Amount of Wind Power (Fiscal 2010)” from METI

II-2. Demand Side Efforts: Accepting the Challenge of Smart Grid Technology

- At present, fluctuations in the output from photovoltaic and wind power systems are compensated by adjusting the output from fossil-fired and hydropower stations. However, as renewable power increases, there may not be enough capacity to absorb fluctuations.
- Utilities are seeking to develop and deploy new systems for controlling supply & demand in anticipation of the massive use of photovoltaic and wind turbine systems.

Concept of the next-generation supply-demand control system



First, photovoltaic outputs must be collected and analyzed.

Roadmap for technological development

Collection and analysis of data (on photovoltaic outputs, etc.)

Development of techniques for predicting photovoltaic outputs, etc.

Development of advanced rechargeable batteries appropriate for frequent recharging and discharging control

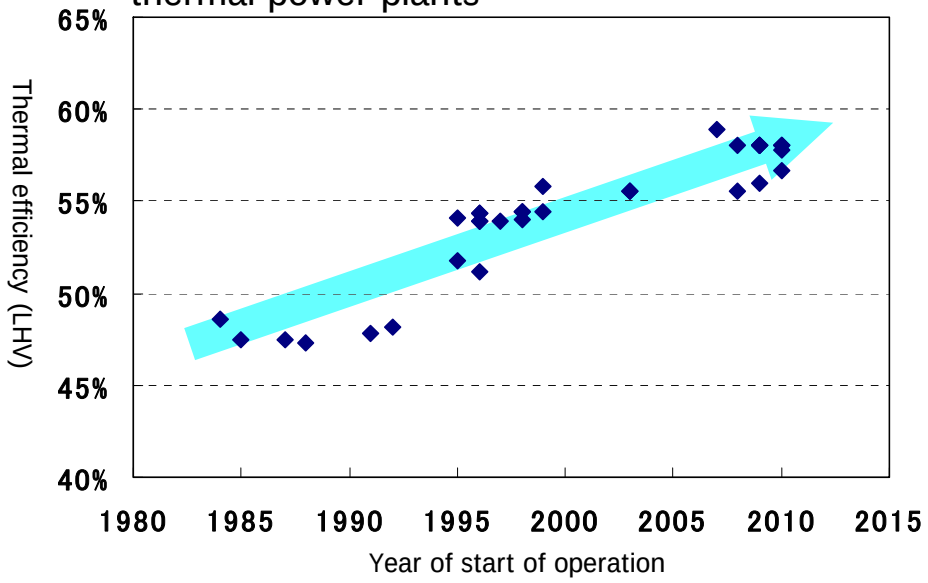
Development of next-generation supply-demand control system

Without the constant management of supply-demand equilibrium, fluctuations in the grid frequency may disrupt industrial activity, etc.

II-3. Supply Side Efforts: Improvement of Thermal Power Efficiency

- The thermal efficiency of combined cycle generation has been improving with the development of high-temperature gas turbines since 1980. Technologies for attaining higher efficiency including installation of 1700℃ class gas turbines will continue to be developed.
- In recent years, higher efficiency has also been achieved in coal-fired power generation through active introduction of Ultra Super-Critical pressure (USC) technology which achieves a high steam temperature. Meanwhile, demonstration tests of integrated coal gasification combined cycle power generation (IGCC) have been carried out for commercialization.

Growth of thermal efficiency at LNG-fired thermal power plants



Examples of coal-fired USC power plants

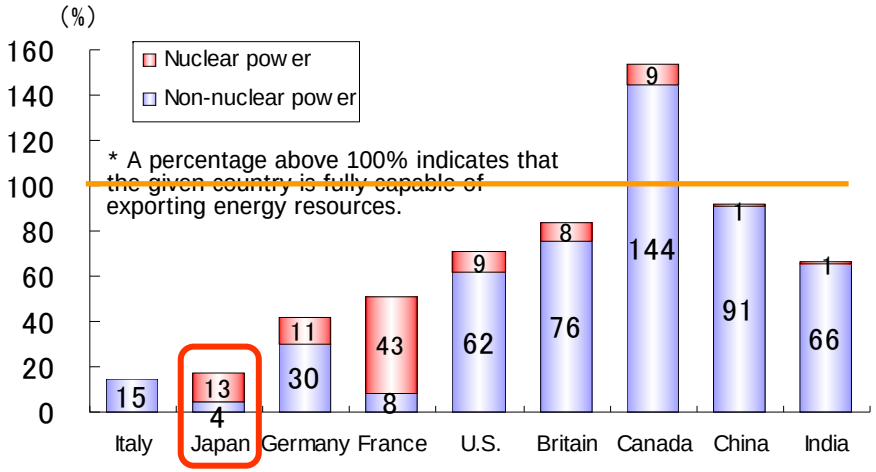
Power plant	Start of operation	Output (MW)	Steam temperature (℃) (main steam/reheat steam)
Hekinan Unit 3	Apr. 1993	700	538/593
Matsuura Unit 2	Jul. 1997	1,000	593/593
Misumi Unit 1	Jun. 1998	1,000	600/600
Tachibanawan Unit 1	Jul. 2000	1,050	600/610
Isogo Unit 2	Jul. 2009	600	600/620

*Among the total output of coal-fired thermal power plants of 40GW, approximately 18GW is produced by power plants adopting USC (Ultra Super-Critical) technology.

II-4. Importance of Nuclear Power (from the Perspective of Three E's)

Energy security

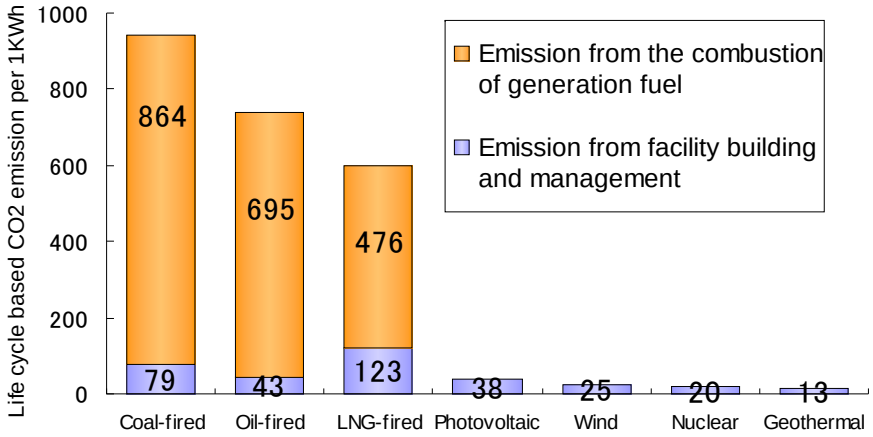
○ Japan's low energy self-sufficiency ratio



Source: IEA Energy Balances of OECD Countries 2009
IEA Energy Balances of Non OECD Countries 2009

Mitigation of Global Warming

○ No CO_2 emission from the power generation process



Source: Central Research Institute of Electric Power Industry

Economy

Yen/kWh	2010	2030
Nuclear	8.9-	8.9-
Coal	9.5-9.7	10.3-10.6
LNG	10.7-11.1	10.9-11.4
Oil-fired	36.0-37.6	38.9-41.9
Land-based wind	9.9-17.3	8.8-17.3
Mega-scale photovoltaic	30.1-45.8	12.1-26.4

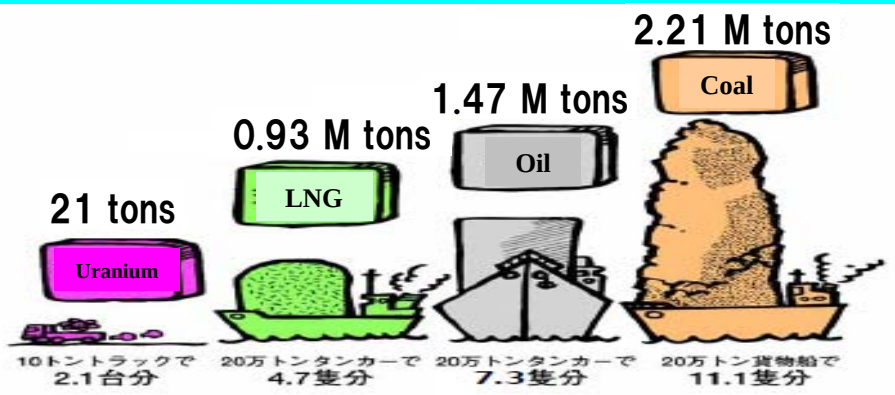
Source: Report from the Committee for Research on Costs, etc. (Dec. 19, 2011)

Nuclear power continues to be an important energy source from the viewpoint of energy security, environmental conservation (mitigation of global warming) and economy on the foremost premise that its safety is ensured.

II-4. Importance of Nuclear Power Generation (Fuel Reserve)

- As enriched uranium can generate several times more electricity than fossil fuels, it has a high efficiency in fuel reserve.
- In addition to fuel already loaded into reactors, the stocks inside the nation can perform a reserve function and continue generating electricity for a few years which will provide us of sufficient time for taking countermeasures even in the event of import disruption.

Fuels necessary for a 1 MW power plant to operate a year (severally)



（出典）電気事業連合会「原子力・エネルギー」図面集2007の数値を同図面集2010の数値に変更

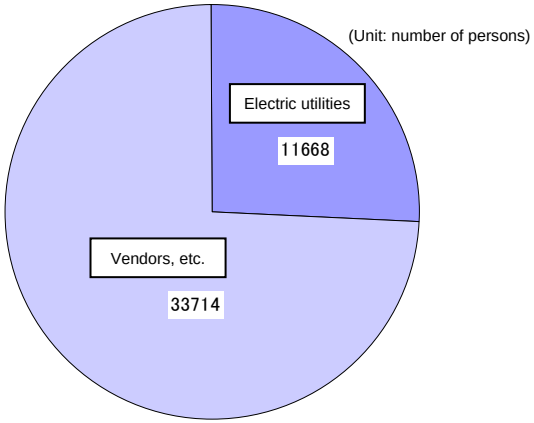
	Oil	Nuclear Fuels
Reserve	8.948 billion litters (enough for 175 days)	Enough for 2.58 years
Calorific value	3.6 EJ	7.70 EJ

Note: Reserve of nuclear fuel consists of the fuel already loaded in the reactors (enough for 1 year consumption) and the stocks stored at the domestic uranium-processing plants (enough for 1.58 year consumption).

II-4. Securing Human Resources in the Area of Nuclear Power Generation

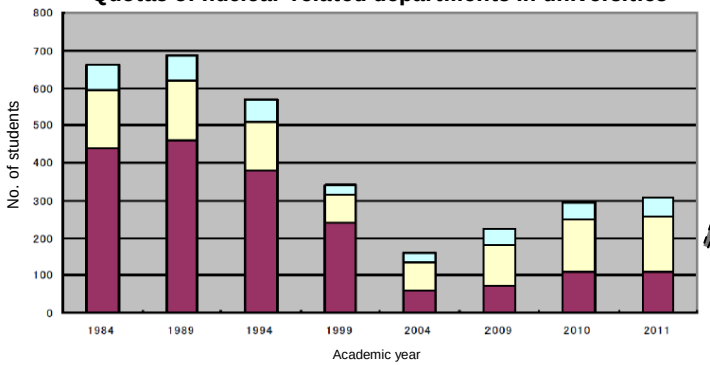
- Ensuring the safety and quality of nuclear power requires capable human resources who are high-minded in safety and have excellent technical knowledge and skills.
- Human resources in the area of nuclear power include approx. 10,000 employees at electric power companies and more employees at their affiliated companies. Human resources must continue to be secured.
- To attract capable human resources, the industry needs to maintain vitality. The role of nuclear power must be well defined and understood.

Personnel engaged in nuclear power (fiscal 2009)



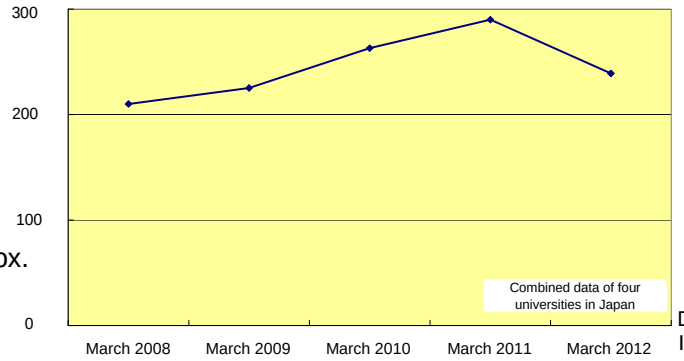
Source: Research on Trend in the Nuclear Power Industry (2009) by JAIF (based on valid responses by 213 companies out of 463 companies contacted for research, including approx. 300 JAIF member companies and 150 non-member companies)

Quotas of nuclear-related departments in universities



Data from MEXT

Number of applicant students for nuclear-related departments in universities



Data from the Japan Atomic Industrial Forum, Inc. (JAIF)

Since Fukushima, the role of nuclear power must be reemphasized, otherwise the nuclear power departments of universities will attract fewer students.

II-4. Utilities' Efforts to Improve Nuclear Safety

Efforts made so far:
ensuring safety by implementing emergency safety measures

Objective:

An accident like Fukushima must never happen again

Prevention of core damage
Prevention of damage to RCV

Multiplication and diversification

● **Securing power sources**

Securing the availability of power sources for main control rooms, etc., by deploying power supply vehicles, etc.

● **Securing means for cooling**

Securing cooling water for reactors and steam generators by deploying fire pumps, etc.

● **Protection against flooding**

Preventing switchboards, batteries and pumps from being flooded

Assessment and verification by stress tests

Further efforts:
Seeking to achieve the world's top level safety

Target:

Achieving the world's top level safety

① Organizational reform

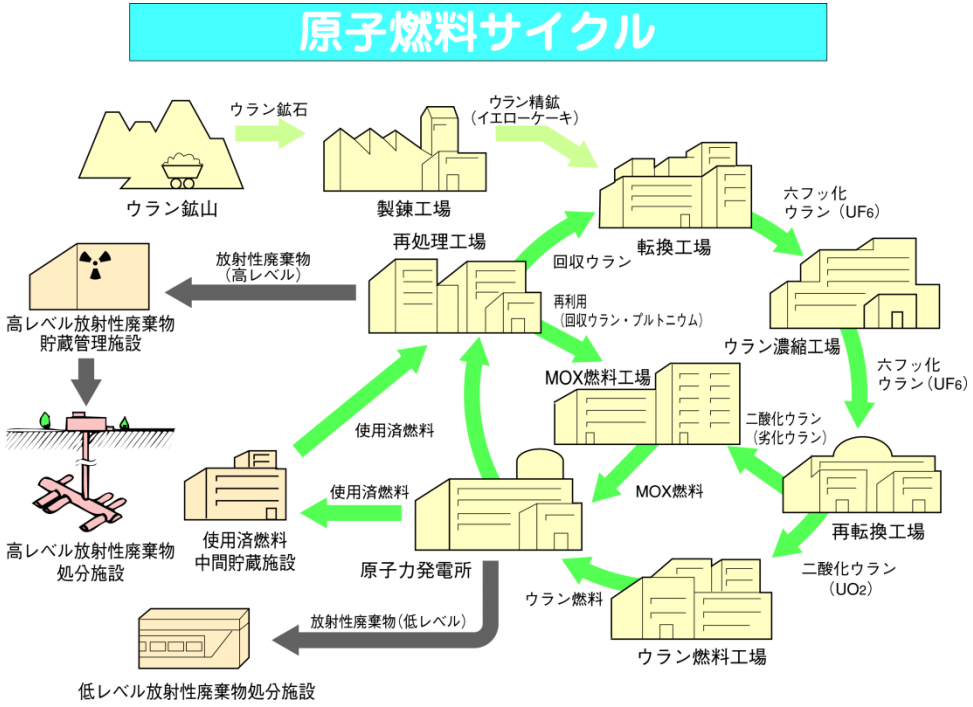
- **A new organization is to be established to continuously promote safety improvement measures.**

② Continuous improvement of facilities

- **Measures for minimizing the long-term evacuation areas due to contaminated soil**
- **Measures for preventing core damage**
- **Measures for preventing damage to the reactor containment vessel**

II-4. Significance of the Nuclear Fuel Cycle

- The nuclear fuel cycle remains vital for the efficient use of limited uranium resources and to reduce the volume of high level radioactive waste.
- Changes in the government's nuclear fuel cycle policy might cause us to lose this energy option. Japan is the only country without nuclear weapons which is permitted to execute this option. New problems might arise accompanying the policy change.



Japan-U.S. Nuclear Power Cooperation Agreement:
The Agreement guarantees Japan's right to seek the reprocessing of nuclear fuel, the only county without nuclear weapons to hold this privilege. This privilege was won by Japan's diplomatic effort based on a relationship of trust with the U.S. If Japan abandons the plan, it may never be allowed again to seek the reprocessing of nuclear fuel.

Excerpt from a memorandum of agreement between the governments of Aomori Prefecture and Rokkasho-mura and Japan Nuclear Fuel:
"If it becomes very difficult to continue pursuing the reprocessing project with certainty, Japan Nuclear Fuel Limited shall promptly take necessary and appropriate measures such as relocating spent fuel away from the facilities, based on discussions among the Aomori prefectural government, the Rokkasho-mura municipal government and Japan Nuclear Fuel Limited." (July 29, 1998)

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III. Conclusion

- We hope that consideration of the best mix of energy sources will be based on a "comprehensive and quantitative examination over the long term" from the viewpoint of S + 3Es.
- Each power source has both merits and demerits. It is important to ensure a well-balanced mix of energy sources.
- Electric power companies are firmly resolved to work on and appeal to the demand side, to expand the introduction of renewable energy sources, to achieve efficient and optimal operation of thermal power generation and to secure the safety of nuclear power.
- We hope the national government will continue to position nuclear power as an important energy source supporting Japan's future optimal energy combination in terms of energy security and other factors.
- Electric power companies will continue to carry out their mission to provide a stable supply of high quality and inexpensive electricity to customers by achieving the goal of S+3Es and by efficiently developing and operating their facilities.